Review Session

Today we recapped the 4 weeks' worth of course material on applications of surfaces & interfaces. These questions are to help you prepare for your oral exams. My recommendation is that you get into a group of two or more and discuss how best to answer these questions – even trying a "mock oral exam" in a group. Good luck preparing for exams and happy holidays!

Part 1: Surface Science

Surfaces in a laboratory become contaminated almost immediately after cleaning. Explain:

1. Why is the contamination process slowed down in ultrahigh vacuum (UHV)? What kind of pressures constitute "UHV"?

2. What factors (beyond pressure) influence contamination rates in both environments?

Part 2: Surface Characterization Techniques

A new nanostructured gold surface has been fabricated for biosensor applications. You want to investigate the following properties of the surface. For each, choose the most suitable technique and justify your choice:

1. Surface topography (roughness and nanostructures).
2. Chemical composition of adsorbed molecules on the surface.
3. Real-time monitoring of molecular adsorption on the surface.
4. Orientation or structural arrangement of molecules on the surface.

Part 3: Nanoscience and Plasmonics

Gold nanoparticles are used for biosensing applications such as the lateral flow assay for the COVID-19 rapid test. Based on the concepts covered in class:

1. Explain how **plasmon resonance** is generated and why gold nanoparticles exhibit distinct colors.

2. How can asymmetric nanostructures (e.g., nanorods or nanoshells) extend the range of plasmonic responses for specific applications?

Part 4: Biosensors

Design a biosensor for lactate using an enzymatic reaction (driven by lactate oxidase). Describe the reaction and the transduction mechanism for an electrochemical signal. What kind of biosensor is this?

Part 5: Catalysis

Sketch a volcano plot for a hypothetical reaction. Explain how changing the catalyst alters the activation energy and predict the optimal adsorption energy.